

Humans, Brains, and Their Environment: Marriage between Neuroscience and Anthropology?

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How do we define ourselves as humans and interact with our various environments? Recently, neuroscience has extended into other disciplines in the humanities and social sciences, questioning the existence of distinct disciplines like anthropology, which describes the relationship between humans and their various environments. However, rather than being incorporated into neuroscience, anthropology may be considered complementary, and a marriage of the two disciplines can provide deep insight into these fundamental questions.

Incorporation versus Marriage

Anthropology is the study of man, what the human being is, what defines him and his world, and what makes us special (or not). Anthropology is a rather hybrid discipline, drawing on different methods borrowed from natural sciences, humanities, and social sciences. The human is investigated in his different facets, his physical and biological constitution in Biological Anthropology, his various cultural and social manifestations in Cultural or Social Anthropology, his origins and predecessors of the early human in Archaeology, and his language in Linguistic Anthropology. But, isn't our brain what makes us special? Our biological and cognitive features allow us to create different cultural and social worlds, to develop our own brain over evolution, and to create a means for communication as wonderful as language. Is our very human nature nothing but our brain's nature? Does anthropology therefore need to be incorporated into neuroscience?

Neuroscience has recently reached out to many disciplines in the humanities and social sciences. For instance, the integration of neuroscience and economics formed the novel discipline of neuroeconomics, which models human decision-making processes in financial contexts. Various other hybrid disciplines are marked by the prefix "Neuro," including "Neurolinguistics," "Neurotheology," and "Neuropsychanalysis." Despite their different origins and contexts, these novel disciplines all share their interest in the brain as the potential origin and "locus"

of the phenomena they target. What makes various human phenomena possible and why do they appear in their specific gestalt? Is the beginning of the 21st century thus the "time of the brain" in the same way the beginning of the 20th century was the "time of the electron"?

Let's take some time for the brain. Neuroscience has made enormous progress in tracking down molecular, genetic, and biochemical processes in the brain. Most recently, the neural mechanisms underlying more complex functions like emotions, memory, free will, self, empathy, social interaction, moral judgments, and consciousness have come into the focus of neuroscience, functions that have long been claimed by philosophers and anthropologists alike to make us human.

Despite the enormous progress in neuroscience, we still do not know what the brain is all about. The philosopher J.R. Searle (1997) argues that we still lack a theory of brain function that describes the purpose or general principle underlying and driving the brain's neural organization. Let's consider other bodily organs. We do have for instance an understanding of heart function; we know that the purpose of the heart is to maintain blood circulation throughout the body, and we know that this is achieved by physiological mechanisms well designed for that purpose. We also know that the kidney clears our body of toxic substances via specific clearance system with distinct anatomical and physiological features, while the purpose of the stomach and the intestine is to

digest and metabolize the food with various enzymes and hormones developed for that specific purpose.

What, however, is the purpose of the brain? As was first pointed out by the philosopher Schopenhauer, we know that our brain is crucial in enabling and predisposing us to develop mental states like consciousness, self, empathy, mind reading, free will, etc. While neuroscientists are understanding the neural mechanisms underlying different mental states more and more, the brain's specific organizational feature that predisposes us to develop mental states, including their various anthropological manifestations, remains unclear. Why can we as humans seemingly not escape having mental states and continuously creating different cultural and social worlds?

What makes anthropology special is that it investigates the relations of humans to their surrounding environment, be it the physical or biological environment, the cultural-social environment, the early environment, or the linguistic environment. These various environments in turn impact us, thus demonstrating bidirectional traffic on the highway between humans and their environments. What remains unclear is what makes such bidirectional traffic possible; this is the point where anthropology converges with neuroscience, since it is the brain and its specific way of organizing its neuronal activity that may enable and predispose such communication between humans and the environment.

Let's have a look at some phenomena at the intersection between neuroscience

and anthropology. I will take a look at how different cultural worlds shape the brain's neural activity, how the brain makes it possible for us to assign value and reward to external stimuli from the environment, how we are able to make decisions in complex social-environmental contexts, and finally how the brain contributes to what is often considered the core of the human itself. This brief excursion into the neural environment of the brain will show that reduction and incorporation of anthropology into neuroscience would neglect the fact that the brain is apparently as dependent upon the environment as the latter is on the former. Hence, anthropology and neuroscience complement each other and can exert mutual influences on each other.

Social and Bodily Contexts

Different cultural environments may deeply impact the brain and its neural activity (see [Han and Northoff, 2008](#), for a review). For example, a recent fMRI study of American and Chinese participants ([Gutchess et al., 2006](#)) demonstrated that culture-specific experiences of object-focused visual processing play a fundamental role in modulating perceptual processes in the visual cortex. Cultural differences may also concern the subject itself. Self-construal, the way in which one understands and explains oneself, plays a key role in social behavior and differs between Westerners and East Asians. The Western self is characterized by an independent style that stresses more self-focused attention, whereas the East Asian self has a more interdependent style that emphasizes the fundamental connections between people in social context ([Lin et al., 2008](#)). Does the cultural difference in self-construals contribute to the cultural difference in perceptual processing? To investigate this, a recent study examined the relation between the styles of self-construals and perceptual processing using a self-construal priming procedure designed to shift self-styles ([Lin et al., 2008](#)). In Chinese participants who were presented with compound stimuli, independent self-construal priming resulted in an enlarged event-related potential component P1 to local than global targets, while the reverse pattern, i.e., larger P1 amplitude to global and local targets, was observed after interde-

pendent self-construal priming. The findings suggest that shifting culture-specific self-construals can lead to changes of visual perceptual processing.

These results clearly show that there is bidirectional traffic between subject and environment that is mirrored in the brain's neuronal activity. Such observations shed new light on an old debate in anthropology: nature versus nurture. What is first: nature (the brain) or the environment (culture)? Experimental observations suggest that this separation is not really appropriate or plausible. The brain itself may defy any such dichotomy, and neural activity may hence neither be classified as purely nature nor as purely nurture. Instead, the brain seems to be able to relate and connect organism and the world in an intimate way. And it is this intimate relationship that in turn seems to allow us to constitute ourselves as humans.

How do specific stimuli in specific cultural contexts obtain importance and significance? The field of reward investigates the neural mechanisms underlying the assignment of value (and hence ultimately reward) to stimuli (reviewed in [Montague, 2007](#)). The assignment of value to stimuli from the environment not only depends on the stimulus itself but also on ourselves and our anticipations and expectations. A recent fMRI study ([Fliebsbach et al., 2007](#)) demonstrates that social context also influences neuronal activity in the reward circuitry. The authors found that neural activity in reward circuitry is determined not so much by the actual stimulus itself (e.g., \$30), but by its relation to the stimulus another person receives at the same time (e.g., \$10 or \$60), thus reflecting the social context within which that stimulus is presented.

The influence of social context on neuronal activity in reward circuitry suggests that the exteroceptive stimuli carrying information about social context must be directly linked to the organism's interoceptive stimuli before any value can be assigned ([Montague, 2007](#)). Such intero-exteroceptive linkage may enable and predispose assignment of value to the original exteroceptive stimulus and hence, the neural realization of the organism's relation to his social context in his reward circuitry. However, intero-extero-

ceptive linkage does not only allow for the social context to imprint itself onto the brain's neural activity. There is also reverse traffic from the brain and the body to the social context, and value assignment is not only dependent on the social context but also on the bodily context as for instance when we are hungry, which can consecutively imprint itself onto the social context. What mediates such bidirectional traffic between bodily and social contexts? Our brain seems to be situated at the crossroads between organism and world, which allows us to constitute ourselves as humans and to create the different environments investigated in anthropology. Hence, the brain itself seems to provide the ground upon which bidirectional traffic between neuroscience and anthropology can be established.

Decision and Self

Our brain provides us with more than mere intero-exteroceptive linkage and value assignment. We are, for instance, able to make decisions and thereby to imprint ourselves onto the environment in ways that are most advantageous to us. In decision making, the decision is not only about the stimuli themselves but also about the subject and its knowledge, purposes, intentions, motivations, etc. (see for instance [Hampton et al., 2006](#)). By acting upon the environment via its decisions, the subject invariably manipulates the environment according to its own needs and thereby creates the different environments, i.e., social, cultural, biological, linguistic, that are the focus of anthropology.

The Anthropologist may still be skeptical and argue that for such imprinting to be possible one needs an agent, a self, who makes the decision and is in charge. What is the self? Our current concept of self has strongly been influenced by the philosopher Descartes, who determined the self as mental entity allowing one to become aware that the thoughts one thinks must be attributed to oneself. Presupposing a Cartesian-like concept of the self as neural (rather than mental) entity, neuroimaging studies investigating neural activity changes during the evaluation of self- and non-self-specific stimuli demonstrated strong activity changes, particularly in the medial

cortical regions of the brain, suggesting that neuronal activity in these areas may be self-specific (see Northoff et al., 2006, for a review).

While we often consider the question of the self to be crucial, it may be even more important to look at the brain itself and its intrinsic features. The brain itself has some intrinsic neural activity even in the absence of any external stimulus, i.e., the resting state activity in the default-mode network (DMN). The degree of resting state activity may strongly impact subsequent neural activity during the processing of external stimuli and predict subsequent mental and behavioral states (see for instance Maandag et al., 2007, as well as Northoff et al., 2010, for review). However, resting state activity does not only impact stimulus-induced activity but the latter may also leave its marks on the former. For example, visual perceptual learning can alter resting state connectivity (Lewis et al., 2009). Taken together, these results show reciprocal entanglement and imprinting between the brain's resting state activity and stimulus-induced activity by stimuli originating from either the environment, as in sensory perception, or the subject itself, as in motor action. More generally, the brain's purpose may be to mediate and constitute such rest-stimulus interaction and thereby to enable and predispose bidirectional traffic with the subsequent development of a rather intimate relationship to the environment. And the perennially looming concept of the self may describe such an intimate relationship of the organism to the world with the subsequent constitution of ourselves as human. Such a brain-based human self may then be considered one of the node points between neuroscience and anthropology.

Transdisciplinary Methodology and Border Stations

Do these examples tell us something about the purpose of the brain, the principle according to which the brain organizes and structures its neural functions and mechanisms? By enabling and predisposing us to bidirectional traffic between organism and world, the brain may be determined to be intrinsically relational; its neural functions and mechanisms are apparently organized and structured in such way that we cannot

avoid relating to the world and thus develop communication between organism and world. In other terms, the brain allows us to access and enter the highway that leads from the organism to the world and back. What enables and predisposes the brain to put the organism on the highway to the world? As I described above, it seems to do so by making its own neural activity dependent on both physical (bodily) and socio-cultural (environmental) contexts. Thus, the brain seems to code its neural activity relative to its respective physical-bodily and social-cultural context, amounting to what one may call "relational coding." Our brain's relational coding enables and predisposes us to reach out to the environment and to impact and manipulate it in the same way it can manipulate us.

Now we are back at our original starting point. I demonstrated the brain's organization and coding of neural activity to be crucial in enabling and predisposing for reciprocal entanglement and imprinting between organism and world. This allows us to not only create different environments (social, cultural, economic, linguistic, etc.) but also to develop a corresponding discipline, anthropology, that investigates our relation to these environments. In short, the brain's specific neural code may be crucial in enabling and predisposing us to develop a discipline like anthropology. But let's be careful and go step by step.

Is this ability to create different environments specifically human? Does our brain's apparent relational coding justify the specific nature of the human as so often hotly debated in anthropology? Rather than being different, neuroscience shows that animals and humans have an astonishing overlap in both their brain's functional organization and social behavior, including their sense of self (see for instance Northoff and Panksepp, 2008). What then makes us as humans so special? One may be inclined to argue that the ability to raise this question distinguishes us from animals. However, the fact that we are apparently not able to give definite answers to this question, as well as others such as nature versus nurture and the mind-brain relationship, may be what makes us unique. Hence, the discrepancy between our ability to raise certain questions and the apparent

concurrent inability to appropriately answer them may be what makes humans special.

What does our brain's apparent relational coding entail for the relationship between neuroscience and anthropology? Neuroscience reveals the necessary conditions of our ability to create different environments that are dealt with in anthropology. Rather than reducing and incorporating anthropology within itself, neuroscience comes to its own boundaries where its empirical-experimental approach is complemented by other methods, like the social and conceptual ones of anthropology. Hence, rather than incorporating other fields, neuroscience may do better by mapping its own boundaries and showing the border stations, the node points between the two disciplines.

What about the discipline of anthropology? It may consider the empirical findings from neuroscience and use them to better understand why the various environments we create take on a particular gestalt rather than another one. Most importantly, by considering the brain and its purpose, including its specific neural code, anthropology may shed some light on the ground it stands on. The encounter with neuroscience will allow anthropology to map its own boundaries and thus, where the two disciplines intersect.

To investigate such border stations, we need a specific methodology, a transdisciplinary and thus truly hybrid method that allows us to link the different domains and contexts of neuroscience and anthropology. And it is here where anthropology provides an already fertile ground since, as mentioned at the beginning, it draws by itself on different methods stemming from the natural sciences, the humanities, and the social sciences. We need to systematically and nonreductionistically link these different methods in order to account for the intersection between human, environment, and brain, which makes it relevant for both anthropology and neuroscience.

Let's come to an end. We know that it is the brain itself that provides us with both information about ourselves as humans and our various environments. We cannot avoid creating novel environments, which has led to the development of a discipline with a methodology as

diverse as anthropology. The marriage of anthropology and neuroscience is wonderful opportunity to gain deeper insight into the nature of man and his various environments. A truly transdisciplinary, and thus hybrid, methodology will promote and foster the interaction between neuroscience and anthropology by revealing common themes. This will ultimately allow us to complement the anthropological search warrant for the self in the brain (Northoff, 2009) with the neuroscientific search warrant for the brain in our various environments.

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REFERENCES

- Fliessbach, K., Weber, B., Trautner, P., Dohmen, T., Sunde, U., Elger, C.E., and Falk, A. (2007). *Science* 318, 1305–1308.
- Gutchess, A.H., Welsh, R.C., Boduroglu, A., and Park, D.C. (2006). *Cogn. Affect. Behav. Neurosci.* 6, 102–109.
- Hampton, A.N., Bossaerts, P., and O'Doherty, J.P. (2006). *J. Neurosci.* 26, 8360–8367.
- Han, S., and Northoff, G. (2008). *Nat. Rev. Neurosci.* 9, 646–654.
- Lewis, C.M., Baldassarre, A., Committeri, G., Romani, G.L., and Corbetta, M. (2009). *Proc. Natl. Acad. Sci. USA* 106, 17558–17563.
- Lin, Z., Lin, Y., and Han, S. (2008). *Biol. Psychol.* 77, 93–97.
- Maandag, N.J., Coman, D., Sangahalli, B.G., Herman, P., Smith, A.J., Blumenfeld, H., Shulman, R.G., and Hyder, F. (2007). *Proc. Natl. Acad. Sci. USA* 104, 20546–20551.
- Montague, P.R. (2007). *Funct. Neurol.* 22, 219–234.
- Northoff, G. (2009). *The Search Warrant for the Ego. A Neurophilosophical Mystery Novel* [German: *Die Fahndung nach dem ICH. Eine neurophilosophische Kriminalgeschichte*] (Germany: Random House Germany).
- Northoff, G., and Panksepp, J. (2008). *Trends Cogn. Sci.* 12, 259–264.
- Northoff, G., Heinzel, A., de Greck, M., Bempohl, F., Dobrowolny, H., and Panksepp, J. (2006). *Neuroimage* 31, 440–457.
- Northoff, G., Qin, P., and Nakao, T. (2010). *Trends Neurosci.*, in press.
- Searle, J.R. (1997). *The Mystery of Consciousness* (London: Granta Books).